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Title: INCIDENT INVESTIGATION FINAL REPORT RLOUB TOPPLED LOAD Near Miss to Personnel Injury

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INCIDENT INVESTIGATION FINAL REPORT

RLUOB TOPPLED LOAD

Near Miss to Personnel Injury

May 21, 2019

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This page contains the signatures of all team members, signifying their agreement with the report content, conclusions, and recommendations.

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EXECUTIVE SUMMARY

On Monday, February 25, 2019, at approximately 1430, the Logistics Central Shop (LOG-CS) Hoisting and Rigging (H&R) crew moved an anti-vibration table on the first floor of Technical Area 55 (TA-55), Building 400, Radiological Laboratory/Utilities/Office Building (RLUOB). The table was designed to be anchored to the facility floor on pedestals to provide vibration dampening for an electron microscope (SEM/TEM). The table was approximately 86 inches wide by 56 inches tall, an asymmetrical load. It weighed approximately 2,300 pounds. The crew was transporting the load using a lifting device, specifically a Vere Optical Table Hoist.

The work control package (Integrated Work Document [IWD] and H&R Ordinary Lift Plan) included staging the table, moving the load from the loading dock through corridors into a laboratory, and installing the table.

During the table move, the riggers made adjustments to the lifting device to enable the load and device to pass through security double doors. After the crew successfully passed through the security double doors, three riggers moved the load approximately ten linear feet further at which point the lifting device and load fell to the RLUOB facility floor. No injuries were sustained as a result of the toppled load and frame. The rigging crew immediately notified supervision who then notified the TA-55 Facility Operations Director (FOD).

After further review, the TA-55 FOD categorized the event as a near miss to personnel injury. The scene was preserved and all H&R operations within the TA-55 directorate were paused pending a review of all lift plans with the rigging supervisor and the Chemistry and Metallurgy Research Replacement (CMRR) Construction Manager. All lift plans were to be reviewed prior to resumption of H&R lifts within the directorate. Additionally, all newly generated lift plans will be reviewed by the TA-55 FOD, the H&R supervisor and the affected manager.

The Associate Laboratory Director for Weapons Production (ALDWP) appointed a team to investigate the event, identify all relevant facts, and determine the direct, contributing, and root causes. The team was also charged with reviewing other similar events to identify common causes for multiple recurring events and the organizational and management weaknesses that have led to failure to correct recurring events. (See Appendix A: Memo, *Appointment of Accident Investigation Board*.)

The following conclusions and recommendations were developed from the reviews of the RLUOB incident and multiple similar events:

Cause	Discussion	Recommendation
Direct Cause	The crew removed one of two hitch pins and one of eight all thread rods that maintained the lifting device	The following recommendations are made to enhance worker appreciation of material handling risks and to enhance

Cause	Discussion	Recommendation
	hoists and frame as a single, rigid unit. The load shifted as it was moved and the lifting device separated, resulting in the toppled load.	awareness of personal safety accountability and aspects of human performance improvement: 1. Engage CMRR project Person in Charge (PIC) as well as LOG-CS H&R craft and supervision in Human Performance Improvement for Workers training. 2. Engage CMRR project management and Logistics craft supervision and management in Safety Culture Leadership immersion workshops (SAFE and/or LOSA). 3. Provide increased CMRR project oversight and coaching in the field to reinforce safe conduct of work expectations, compliance with safety requirements expectations, effective pre-job brief expectations, and a questioning attitude towards potential safety risks and appropriate risk mitigation. 4. Provide Master Rigger training for Logistics H&R supervisors to enhance appreciation for appropriate Conduct of Operations as well as advancing their technical knowledge with respect to material handling and H&R activities.
Root Cause 1	**Improper categorization of the lift** 1. The RLUOB lift plan was initially described as an "Ordinary Lift" by the planner. This was not challenged by the Logistics	1. LANL Associate Laboratory Director for Environment, Safety, Health, Quality, and Safeguards & Security (ALDESHQSS) should incorporate specific jack and roll requirements into P101-25 that include categorization

Cause	Discussion	Recommendation
	H&R supervisor or the H&R RLM although the load was asymmetrical, the center of gravity was below the horizontal midpoint of the load, and the riggers had not used the lifting device previously. 2. P101-25, *Cranes, Hoists, Lifting Devices, and Rigging Equipment*, is not explicit in terms of lift categorization expectations nor is it explicit about material handling activities such as jack and roll operations. This led to a lift plan that was inaccurate and ineffective. 3. P101-25, *Cranes, Hoists, Lifting Devices, and Rigging Equipment,* as written, does not approach lift activities from a conservative position. Therefore, the controls associated with a critical lift were not applied to this evolution (such as consideration for a "dry run," verified removal of travel path obstructions, etc.).	criteria that are consistent with H&R applications. 2. LANL ALDESHQSS should eliminate "moderate" as a lift categorization for both lifting and material handling. 3. LANL ALDESHQSS should ensure that the use of non-routine material handling and/or lifting equipment results in a critical lift (or equivalent for material handling) categorization, thus driving specific considerations in the lift plan (or material move plan) development. 4. LANL ALDESHQSS should ensure that either P101-25 and/or a separate requirements document for jack and roll operations is set up in a conservative manner such that a critical lift (or move) is assumed until specific questions are answered that result in the activity moving from the critical lift categorization into ordinary lift, including the consideration of routine or non-routine lifting and moving equipment.
Root Cause 2	**Inadequate lift plan** 1. The lift plan (not required for ordinary lifts) did not address key aspects of moving the load; e.g., transition points from elevated to zero energy, securing the load, cribbing, preventing hands from being under the load, or verifying a	1. LANL should develop additional content criteria for inclusion in all lift plans, including ordinary lift plans; e.g., transition content, contingency plans, and means to support safe loading and movement. 2. Logistics leadership should develop criteria for when an ordinary lift requires a lift plan.

Cause	Discussion	Recommendation
	viable path of travel prior to moving the load. 2. The lift plan was not executable as written. It did not consider that the toe jacks were positioned where the clamping frame needed to be positioned at the same time. It did not consider the irregular shape of the table and the resulting asymmetrical center of gravity associated with the load. Consequently, the load could not be affixed in a manner fully consistent with the manufacturer's instructions for the lifting device: the load was not affixed with the center of gravity at the position of the lifting device gimbal pins.	The LOG-CS H&R department currently develops lift plans for all ordinary lifts. The investigation team concluded that this practice is diluting the rigor applied in lift plan development and therefore dilutes the value extracted from the lift plan.
Root Cause 3	**Inadequate work planning and work release led to a failure to invoke intended "hold points" during work execution.** 1. The IWD addressed the security door threshold removal and the security door alarm (in terms of re-activation, not specifically de-activation) but these were not communicated to the H&R supervisor and crew. 2. The IWD did not include a validation walk-through to ensure that the load and lifting device could freely travel through points of constraint along the path.	LANL ALDESHQSS and Associate Laboratory Director for Capital Projects (ALDCP) should enhance H&R and material move work planning requirements as follows: 1. Ensure the planner and the H&R supervisor are present for the scoping walk-down along with the PIC, that they agree on any activity hold points, and that they jointly determine whether those hold points will be specified in the IWD or the lift plan (if an ordinary lift is being executed, the hold points should be in the IWD since a lift plan may not be required). 2. Work planning for such activities should include a hard requirement

Cause	Discussion	Recommendation
	3. The H&R supervisor was not present at planned scoping walk-downs (in which controls for the work were suggested and/or intended to be refined in order to include them in the work package/IWD). 4. The PIC expected the crew to assemble the lifting device and load and then stop and await his return. He left the work area without communicating this expectation to the crew and his intended hold point was not included in the IWD. 5. The H&R supervisor initiated work without a pre-job brief of the IWD conducted by the PIC, as required by P300, so was not aware of the controls within the IWD relative to the security door alarm or threshold. Instead, the H&R supervisor reviewed only the lift plan with his rigging crew as well as the manufacturer's instructions for the lifting device. 6. The approval of the IWD on the day of the work contributed to an ineffective review of the IWD.	to validate the travel path, physical constraints along the path, and removal of obstructions prior to conducting a material move. 3. Line management should enforce effective pre-job briefs including the discussion and reinforcement of activity hold points. 4. ALDESHQSS should determine whether P300 provides for appropriate Subject Matter Expert (SME) review requirements for a lift plan that is part of a work package but separate from the IWD.
Contributing Cause 1	**Inadequate oversight** The lack of a non-working supervisor or PIC and inadequate communication between the	1. LANL ALDESHQSS should modify P300 as well as P101-25 to require the presence of a non-working PIC for H&R and material handling activities.

Cause	Discussion	Recommendation
	construction PIC and the Logistics H&R supervisor led to a failure to invoke certain controls listed in the IWD, to ensure a work environment that was less chaotic and distracting, and to appropriately pause the activity instead of modifying the lifting device while under load.	2. LANL ALDESHQSS should modify P300 to require a non-working supervisory role for all moderate and high hazard jobs.
Contributing Cause 2	**Lack of material moving equipment familiarity** The Logistics H&R crew was not experienced with the lifting device nor did their processes or procedures require more in-depth familiarization with new equipment prior to using it in a scheduled or actual work evolution. This resulted in the load not being properly affixed to the lifting device.	Logistics H&R should enhance work planning processes and procedures to ensure familiarity with material handling equipment prior to use by rigging crews.
Contributing Cause 3	**Low perception of risk** The Logistics H&R crew and the CMRR PIC perceived the move task as low risk. This perception hindered everyone involved from exhibiting a questioning attitude and pausing work. This perception was demonstrated by a failure to conduct a pre-job brief, discussion of a non-viable travel path the morning of the move, and willingness to reconfigure the lifting device while under load.	Line management within Capital Projects and Logistics should reinforce the obligation to pause or stop work when conditions have changed or work cannot be performed as planned and documented in the IWD and/or lift plan/operational plan.

Additional recommendations from a review of similar events:

Issue	Discussion	Recommendation
Demonstrating value of safe performance of work as part of production	In all work, personnel are continuously evaluating and determining when to emphasize efficiency and when to emphasize thoroughness. In project work, as with production work, milestones and	1. Line management within Capital Projects and Logistics should develop expectations for field observations and coaching to reinforce expectations to perform effective pre-job briefs that

and/or project work execution	work schedules are continuously emphasized. This creates an environment in which deliberate emphasis must be applied to ensure that work is executed in a safe manner.	include specified content to recognize the approved work bounding conditions and to pause when work cannot be performed within the planned boundaries. 2. Line management within Capital Projects and Logistics should ensure that the project schedule includes tasks to scope work and that resources including the planner, specified SMEs, and the PIC are required to be present for the scoping walk-down and to revise and refine the preliminary information that is supplied by the planner. This should be a hard requirement and subject to management observation and evaluation. 3. Logistics and Capital Projects should ensure that work package review is conducted by SMEs in advance of the work execution in alignment with Conduct of Operations principles outlined in P315, Attachment 16, as well as P300 and PA-AP-01000 from TA-55.
Deliberate application of relevant Lessons Learned	The Joint Accident Investigation Team identified the fact that a subcontracting crew involved in the December event was not aware of previous event lessons learned involving the same subcontractor. Neither were Logistics H&R personnel familiar with the December subcontractor event or lessons learned (as discovered by this investigation team.) Failure to use such lessons to inform current work planning and work execution	Logistics and Capital Projects should require that work planning and scoping include review of previous lessons learned and incorporation of the lessons learned into the current work plan, reference of the lessons learned, and review of the lessons learned during pre-job briefs.

	practices reflects a failure to emphasize organizational learning.	

1.0 BACKGROUND

1.1 Investigation Authority

The Associate Laboratory Director for Weapons Production appointed an accident investigation team on March 5, 2019, as described in ALDWP: 19-006. The investigation team was to determine the direct, contributing, and root causes of this particular event. In addition, the investigation team was charged with reviewing similar events to understand common causes across these events and to identify organizational and management weaknesses that led to a failure to correct such recurring issues.

The team examined a set of 11 Occurrence Reporting and Processing System (ORPS) reportable and sub-reportable events in addition to the February 25, 2019 toppled load at RLUOB. This set of similar events included injuries or near miss events resulting from equipment and material drops from over head, a near miss from forklift operations, classic H&R incidents, and material handling events across LANL. The sample set of events spanned from 2016 to the initiation of this particular investigation. Of particular interest to the appointing officials, and specifically called out in the appointment letter, were three recent events: a dropped spool piece in RLUOB in September, 2018; a dropped UPS load at TA-55, Building 351; and, a dropped lifting attachment during a construction project in December, 2018 that resulted in a significant injury.

1.2 CMRR Project Description

The CMRR project was established to ensure continuity in enduring analytical chemistry and materials characterization (AC/MC), to modernize nuclear materials research and production, and to provide actinide research and development capabilities essential to NNSA's stockpile stewardship and other plutonium and nuclear missions.

Currently, one CMRR subproject (RLUOB Equipment Installation 2, [REI-2]) is ongoing at TA-55. RLUOB will serve as a multifunction facility that provides 19,500 square feet of laboratory space for chemical and materials analysis by modifying ~10,000 ft^2 of laboratory space, procuring and installing 74 ventilated enclosures, and installing AC/MC programmatic equipment. The Material Science and Technology (MST-16) organization is a tenant within RLUOB. This organization provides materials science, technology, and hardware essential to ensuring and assessing weapons materials performance.

The subject of this investigation involves the staging and material handling of MST-16 programmatic equipment, primarily an anti-vibration table upon which an SEM/TEM microscope was to be installed. On February 25, 2019, a Logistics H&R crew, permanently deployed to TA-55, positioned the anti-vibration table in a lifting device made by Vere and initiated transport of the load. During the load transport, the rigging that held the load was

modified in order to lower and transport the load through a security door within RLUOB. The load was successfully maneuvered through the security door. Shortly thereafter, the lifting device separated and the load toppled to the facility floor.

2.0 ACCIDENT FACTS

2.1 Chronology of Events on the Day of the Accident

At approximately 0900, the PIC, the Logistics H&R supervisor, and three riggers arrived at RLUOB and walked the path of travel for the anti-vibration table. During the walk-down, they observed scaffolding blocking the path to the designated room. The PIC informed the rigging crew that the scaffolding would be removed before the table was moved. The H&R supervisor informed the PIC that the rigging crew had an H&R move with the Vere Optical Table Hoist scheduled for the next day at TA-55, Building 4.

After the walk-down, the PIC left the work area to obtain the required IWD approval signatures for the move and install task. The H&R supervisor and the riggers proceeded to the loading dock to inspect the table. Soon after they arrived at the dock, Nuclear Process and Infrastructure, Hazardous Material Management (NPI-7) personnel transported with a forklift the crated table from storage to a staging area near the loading dock.

The rigging crew removed the Vere Optical Table Hoist assembly from storage and transported it to the loading dock. The H&R supervisor and the riggers had not used the Vere Optical Table Hoist. However, a few days before, the H&R supervisor reviewed the Vere instruction manual and a video to become familiar with the mechanics of the lifting device. Before the rigging crew started its work, the H&R supervisor provided the three riggers with the manual and they reviewed it. The supervisor asked the three riggers if they understood the manual and if they were comfortable using the lifting device. The three riggers informed the supervisor that they understood the manual and felt comfortable using the lifting device.

At approximately 1300, carpenters removed the crate siding to expose the table that remained resting on a pallet. The PIC handed the work package binder to the H&R supervisor and left for a meeting. The supervisor reviewed the H&R lift plan with the three riggers. Then the supervisor and the riggers signed Part 3, *"Validation and Work Release"* of the IWD. A representative from the vendor, employees of the organization who purchased the microscope, and security representatives arrived to observe the table move.

The rigging crew commenced its work, positioning toe jacks essentially at the four corners of the table. Using the jacks, the crew lifted the table off the pallet a few inches and placed dunnage below the load for additional stability. NPI-7 personnel then positioned the tines of a forklift below the table and moved the table to the dock. While NPI-7 personnel maintained the table at about waist height with the forklift, the riggers secured the table in the Vere lifting device. The riggers accomplished this by placing the clamping frames on each side of the table while it was in a horizontal position and then securing it using eight all thread rods. The riggers pivoted the

table to an upright vertical position, then raised and lowered the table to verify stability of the load. **Photo 1** was taken once the load was stabilized.

The riggers began moving the load. The H&R supervisor was guiding the load by pulling on the lifting device frame while two riggers were pushing the load from the other end. A third rigger was carrying the toe jacks.

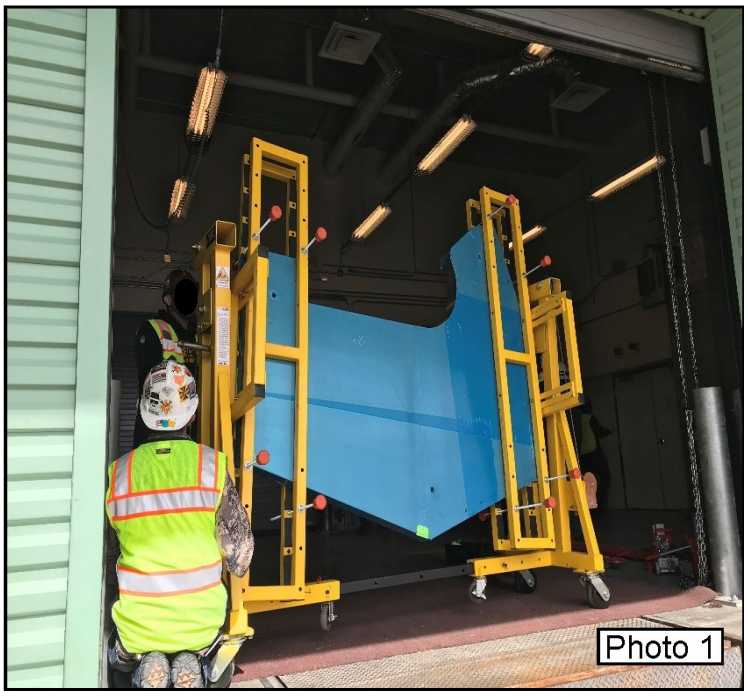


Photo 1

The rigging crew successfully passed through three high-bay roll-up doors and approached the security double doors. The rigging crew immediately noted that the table and lifting device assembly would not pass through the security double doors in an upright vertical position because the frame extended approximately 4 inches higher than the door frame.

At this time, the rigging crew was surrounded by observers, some of whom were commenting on the job and/or advising them. One of the observers touched the load and the H&R supervisor enforced the cone of safety requirements.

The rigging crew then discussed the situation and decided to lower and tilt the load to get through the door. As the crew tried to lower the load, the clamp assembly contacted the cross connector of the lifting device, limiting the ability to lower the load further. The rigging crew hoisted the load up, removed one of two cross connector hitch pins that connect the two towers, and lowered the load again. As the crew attempted to pivot the load, one of the four all thread rods supporting the load on the longer side of the lifting device interfered with the cross connector. The rigging crew removed one all thread rod and rotated the load to clear the header of the security double doors.

As the crew initiated the move through the security double doors, the escorts repeatedly and emphatically reminded them that the security alarm would activate if the transition took 90 seconds or more. The riggers proceeded through the security door knowing they had only 90 seconds before the security alarm activated. As they attempted to cross the threshold while manually maintaining the tilt of the lifting device, they had to backup and forcefully push and pull the load over the threshold.

Photo 2 was taken once the crew passed the security door with the load.

The rigging crew then proceeded along the travel path without replacing the hitch pin or the all thread rod.

As the riggers approached the entrance to the designated room, they noticed the path was till blocked by scaffolding.

The H&R supervisor then decided to use the alternate path that had been identified during the morning walk-down.

Approximately 10 feet along the path, the lifting device and load fell over as seen in **Photo 3.**

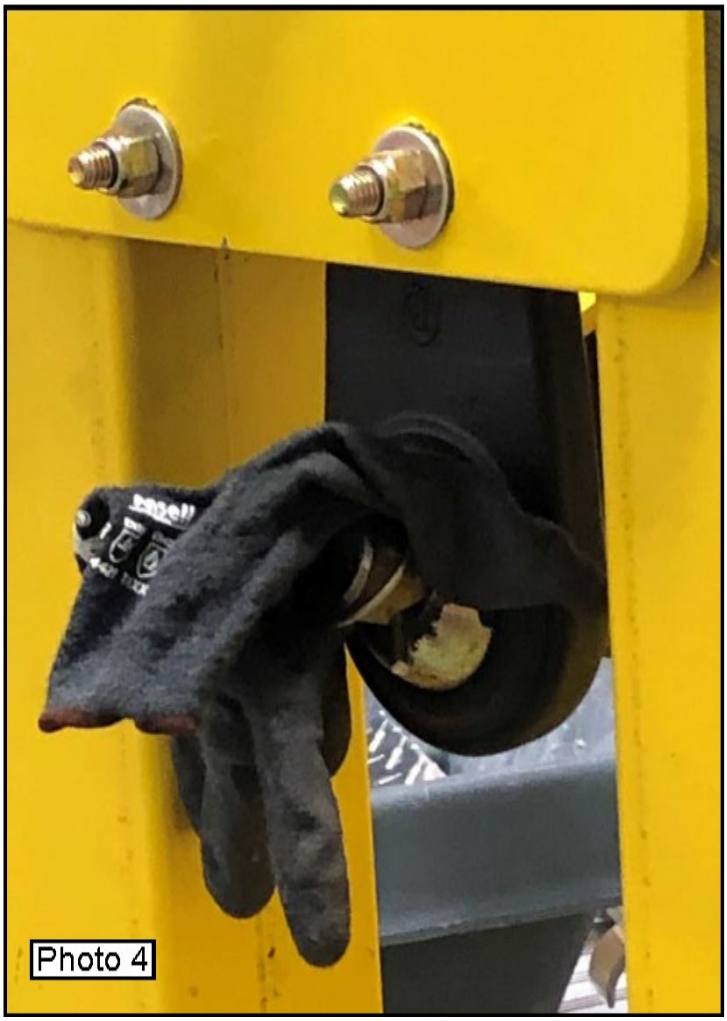


Photo 4

The rigging crew was able to move away from the falling load without any injuries.

However, one of the H&R supervisor's safety gloves was caught and remained in the lifting device assembly as seen in **Photo 4**.

2.2 Work Planning – Work Control Process

On November 20, 2018, the CMRR REI-2 work package manager requested the primary planner to prepare a Work Order (WO) and IWD. This work package was to cover the transportation, anchoring, and associated security protocols for the movement and installation of a Titan Themis 300 Electron Microscope in a designated laboratory. The planner requested the supporting documentation from the work package manager and received the *Scios Pre-Installation Manual, Titan Themis 300 Low Base, SBT 436764-5009,-5015, 0435525-3003-02*. With the supporting documentation, the primary work planner created WO 628504-3, titled "TEM/SEM MOVE/INSTALL."

On November 27, 2018, the REI-2 work planner scheduled a walk-down to support development of the IWD. The attendees included the primary planner, the REI-2 Construction Superintendent/PIC for the task, the LOG-CS H&R Responsible Line Manager (RLM), and a

security representative. The H&R supervisor responsible for moving the table was invited but could not attend the walk-down due to schedule conflicts.

During the walk-down, the planner filled out an AP-WORK-0002, "Standard Activity Planning and Scoping Checklist." On this checklist the planner made the following notations:

- The lift was identified as an ordinary lift.
- Scaffolding needed to be removed from the travel path.
- A 50-inch width constraint existed along the path.
- The load had to be configured to get through doorways.

The scoping walk-down contained two additional notes: the riggers could use a gantry crane; and, carpenters and security personnel would be on standby to remove the security double doors threshold and deactivate the security sensor.

On December 12, 2018, the primary planner scheduled a second scoping walk-down. The attendees included the primary and secondary planners and a security representative. Notes from this walk-down indicated the need to coordinate with security to deactivate and reactivate security door alarms and to ensure security escorts were present. Notes were also made indicating that the table was available for inspection by the H&R crew.

In December, 2018, the TA-55/RLUOB H&R supervisor made a request of his management to use the Vere Optical Table Hoist to transport the anti-vibration table into RLUOB. The lifting device was subsequently moved into storage at TA-55.

On December 19, 2018, because the H&R supervisor had not attended the scoping walk-downs, he requested time with the REI-2 primary planner and/or PIC to perform a walk-down of the move in order to develop the H&R lift plan. The PIC and the H&R supervisor performed a walk-down of the move that day.

On December 21, 2018, the PIC provided the H&R supervisor the documentation for the anti-vibration table, *"STB-435535-3003-02-1, Pre-Installation-Titan Themis 300 Low Base."*

On January 15, 2019, the planner provided the H&R supervisor and the PIC the documentation *"Appendix D-2 Scios Pre-Installation Manual.pdf; and Pre-Installation-Titan Themis 300 Low Base and SBT 43674-5009,-436764;-435525-3003-02-1,"* which included a table drawing and dimensions.

2.3 Work Planning – Lift Plan

On January 15, 2019, the H&R supervisor reviewed the table drawing and developed an ordinary lift plan, *"Transporting and setting the TEM Vibration Pad."* The lift plan identified safety requirements and included the following verbatim work steps:

1) Mobilize tools and equipment to the south loading dock airlock.
2) RLUOB warehouse team will transport TEM vibration pad to loading dock.

3) Stage TEM vibration pad in airlock.
4) Craft will set up Vere Optical Table Hoist in a designated area.
5) Place a toe jack on each end of the pad (4 toe jacks total).
6) In sequence raise TEM pad high enough so that the table hoist may be connected.
7) Connect and secure the TEM vibration pad to the Vere Optical Table Hoist.
8) Raise the pad 2-4 inches to verify load stability.
9) Craft will then travel with the Vere/TEM vibration pad to the designated lab room.
10) Using the Vere Optical Table Hoist rotate the HDV Chiller [*sic*] from a horizontal to a vertical position so that it may transport through a standard double door.
11) Once the TEM pad has reached its designated area, rotate pad to a horizontal position.
12) In sequence the table hoist operators will begin to lower the TEM pad**.** Note: The two other craft members will assist in guiding the TEM pad down.
13) Once the table hoist has reached its lowering limit, craft will reset toe jacks along the TEM pad (4 total).
14) In sequence raise toe jacks high enough so weight of the TEM pad is distributed on the jacks.
15) Once load stability has been verified disconnect Vere Optical Table Hoist and place in a safe configuration.
16) Toe jack operators will lower and set the TEM vibration pad in its final location.
17) Remove tools and equipment and place in a safe configuration.

On January 23, 2019, the H&R RLM approved the ordinary lift plan based on the completed Form 1611, *"Ordinary Lift/Moderate Risk Lift Procedure."* The H&R RLM then provided the approved lift plan to the REI-2 work package manager and the primary planner. The RLM requested the planner to ensure facility requirements were completed, the work was set to "ready", and that work was scheduled in accordance with the plan of the day/plan of the week requirements. The package included Form 1611, *"Ordinary Lift/Moderate Risk Lift Procedure"* and Form 2215. Form 2215 is a non-mandatory job-aid form that guides personnel through task prerequisites to determine if the prerequisites are applicable and if so, to ensure they have been completed.

At this time, the move and install task was scheduled for March 4, 2019. This date had been adjusted several times to accommodate other task delays, such as HVAC tie-ins, etc.

On January 28, 2019, the primary planner provided the H&R lift plan to the PIC. The PIC requested that Ground Penetrating Radar be performed on the cement floor of the laboratory to identify acceptable anchoring points for the table. (Note: At some point prior to approval of the move and install work package, the PIC requested the carpenters to create a template of the table to aid in identifying the anchor points.)

2.4 Work Planning – IWD

On January 29, 2019, the IWD for the WO 628504-03, *RLUOB REI-2 LAB SEM/TEM Equipment Move-In* was signed by the primary planner. The IWD refers to the H&R lift plan and identified requirements to include:

- Section 2 – "Precautions and Limitations", Section 2.5. If steps cannot be completed as described, or if unforeseen situations occur, PAUSE WORK, stabilize the situation, contact your supervisor, and await further instructions before proceeding.

- Section 3 – "Prerequisites and Initial Conditions, Man-Lift/Aerial". Perform daily inspection before operation in accordance with 40-25-013, "Man Lift Inspection and Maintenance." Operate the lift in accordance with manufacturer's specifications. Boom and articulating arm must be lowered sufficiently to clear overhead obstructions prior to repositioning the lift.

- Section 3.1 – Perform the Pre-Job Brief. Fill out the IWD, Part 3. Provide daily pre-job briefs before each scheduled day.

- Section 3.7 – PIC SHALL SEQUENCE move.

- Section 5 – "Special Tools and Equipment". Completed, Approved, Published Lift Plan (attached). CARPENTER TOOLS CONSISTENT WITH AND SUPPORTING UNCRATING SHIPPING BOXES, REMOVAL OF DOORS, THESHOLDS AND RELOCATION OF INSTALLED FURNITURE, FIXTURES AND EQUIPMENT.

- Section 7 – EQUIPMENT INSTALLATION LAB

    - 7.1. PIC SHALL SEQUENCE INSTALLATION. Includes interaction with adjacent trades, contractors, relevant vendors mounting appliances, existing and future furniture, fixtures, equipment and instruments. Coordinate LIFT PLAN (Completed Form 2215, "Hoisting and Rigging Checklist"; Form 1611, "Moderate Risk Procedure"). Escorts (full time door is breached).
    - 7.3. **VERIFY** Hoisting & Rigging Operator Checklist FORM 2215 is completed and filled out to PIC's satisfaction.

2.5 Work Planning – Execution

After the H&R lift plan was provided to the PIC on January 28, 2019, the PIC requested that Ground Penetrating Radar be performed on the cement floor of the laboratory.

On Thursday, February 21, 2019, the PIC and CMRR REI-2 management decided to accelerate the move and install task, moving the date up one week to February 25, 2019 in order to

accommodate the SEM/TEM vendor schedule. The vendor was to be present in order to ensure the table was not damaged and was intact upon installation. Specific activities identified in the initial scoping checklist were not acted upon by the project personnel at this time (e.g., ensure that scaffolding was removed from the intended path of travel for the load.)

On Monday, February 25, 2019, the PIC followed up with verbal communication to the Logistics H&R department to ensure that the TA-55 rigging supervisor and crew knew the move had been rescheduled for that day. The PIC walked through RLUOB with the rigging supervisor and crew and discussed the intended travel path as well as a potential alternate path. At this time, scaffolding was still present and partially obstructing the intended path of travel.

The PIC then hand-carried the work package to various SMEs and the facilities management to obtain work authorization and release approvals and signatures. Meanwhile, the H&R crew and supervisor examined the load and staged the lifting device at the RLUOB loading dock. The PIC returned to the staging area and provided the work package binder to the H&R supervisor.

At approximately 1300, the PIC again departed the dock area to attend a meeting. The H&R supervisor and crew reviewed the lift plan and signed the IWD, Part 3. (The absence of a pre-job brief did not meet the requirements of P300, *Integrated Work Management*.)

The lack of a pre-job brief resulted in critical communication failures. The PIC did not clearly indicate his intentions to the crew. The crew did not understand several critical aspects of the work. Specifically:

- The PIC intended for the rigging crew to assemble the load in the lifting device and then pause until he returned.
- The rigging crew was unaware that the security double door threshold could be removed.
- The rigging crew was unaware that the security door alarm could be temporarily deactivated.

During the execution of the material move, the rigging crew encountered difficulties transiting the security double doors. The riggers paused to discuss possible solutions. They agreed to remove a hitch pin and an all thread rod from the lifting device while under load in order to lower the load below the door header, leading to the event as described in Section 2.1 above.

2.6 Oversight

The investigation team examined oversight activities by Environment, Safety, and Health (ES&H) employees as well as the project management team at RLUOB. The construction safety personnel provided monthly activity reports reflecting their oversight across various construction projects. The detailed monthly reports discussed multiple oversight activities including craft safety observations, incident or injury investigations, pause work occurrences, and discussions of mentoring and coaching that took place in the field. Following are some examples of oversight activities:

- October, 2018: Craft field safety advocates completed 213 craft safety observations and coaching was provided on personal protective equipment (PPE), barricading, fall protection, electrical safety, use of seat belts, and use of spotters. Multiple documented observations occurred in RLUOB.

- November, 2018: The monthly report cited 205 craft safety observations and coaching and mentoring in PPE, lock out/tag out (LO/TO), barricading, fall protection, electrical safety, heavy equipment, housekeeping, and motor vehicle safety belt use. Specific to RLUOB, the use of an office chair instead of a ladder by carpenter craft was addressed as well as sheet metal workers not properly securing material.

- December of 2018: The report indicated 185 craft work observations were made including topical areas cited above as well as observations specific to cranes and hoists. Again, multiple observations were made in RLUOB and included improperly attached equipment at heights.

- The January/February report indicated around 200 observations, including 10 RLUOB IWD reviews and 76 REI/PEI (PF4 Equipment Installation) work observations for compliance.

These monthly reports reflect active involvement and oversight from the ES&H construction personnel and reflect continuous use of coaching, mentoring, and correcting at-risk behaviors. Unfortunately, these observations and correction activities did not prevent particular behavior such as the lack of a pre-job brief on February 25, 2019.

The investigation team requested similar oversight information from CMRR project personnel. Although some project personnel indicated that field observations were conducted, they provided no documented evidence of such field observations, coaching, and correcting.

In addition, the investigation team reviewed the Joint Accident Investigation report, *Construction Lifting Accident at the Los Alamos National Laboratory Results in Serious Injuries to a Subcontract Employee on December 19, 2018*. The report identified similar weaknesses in the effectiveness of oversight of work being performed.

3.0 ACCIDENT RESPONSE

The scene was preserved and all H&R operations within the TA-55 directorate were paused pending a review of all lift plans with the rigging supervisor and the CMRR Construction Manager. All lift plans were to be reviewed prior to resumption of H&R lifts within the directorate. Additionally, all newly generated lift plans are to be reviewed by the TA-55 FOD, the H&R supervisor, and the affected manager.

The ALDWP appointed a team to investigate the event, identify all relevant facts, and determine the direct, contributing, and root causes. The team was also charged with reviewing other similar events to identify common causes for multiple recurring events and the organizational and management weaknesses that have led to failure to correct recurring events. (See Appendix A, Memo, *Appointment of Accident Investigation Board*.)

4.0 ACCIDENT ANALYSIS

The investigation team evaluated the facts associated with the event timeline, roles and responsibilities of the various involved personnel, management systems associated with planning and executing the work, and the role of work execution oversight. The team completed a Barrier Analysis and an Events and Causal Factors analysis. (See Appendices B and C.) Both tools support the identification of actions and conditions that were potentially causal to the event and identify what barriers were ineffective in preventing the event. These resulted in identification of direct, contributing, and root causes to the event.

The following conclusions and recommendations were developed from the reviews of the RLUOB incident and multiple similar events:

Cause	Discussion	Recommendation
Direct Cause	The crew removed one of two hitch pins and one of eight all thread rods that maintained the lifting device hoists and frame as a single, rigid unit. The load shifted as it was moved and the lifting device separated, resulting in the toppled load.	The following recommendations are made to enhance worker appreciation of material handling risks and to enhance awareness of personal safety accountability and aspects of human performance improvement: 1. Engage CMRR project Person in Charge (PIC) as well as LOG-CS H&R craft and supervision in Human Performance Improvement for Workers training. 2. Engage CMRR project management and Logistics craft supervision and management in Safety Culture Leadership immersion workshops (SAFE and/or LOSA). 3. Provide increased CMRR project oversight and coaching in the field to reinforce safe conduct of

Cause	Discussion	Recommendation
		work expectations, compliance with safety requirements expectations, effective pre-job brief expectations, and a questioning attitude towards potential safety risks and appropriate risk mitigation. 4. Provide Master Rigger training for Logistics H&R supervisors to enhance appreciation for appropriate Conduct of Operations as well as advancing their technical knowledge with respect to material handling and H&R activities.
Root Cause 1	**Improper categorization of the lift** 1. The RLUOB lift plan was initially described as an "Ordinary Lift" by the planner. This was not challenged by the Logistics H&R supervisor or the H&R RLM although the load was asymmetrical, the center of gravity was below the horizontal midpoint of the load, and the riggers had not used the lifting device previously. 2. P101-25, *Cranes, Hoists, Lifting Devices, and Rigging Equipment*, is not explicit in terms of lift categorization expectations nor is it explicit about material handling activities such as jack and roll operations. This led to a lift plan that was inaccurate and ineffective.	1. LANL Associate Laboratory Director for Environment, Safety, Health, Quality, and Safeguards & Security (ALDESHQSS) should incorporate specific jack and roll requirements into P101-25 that include categorization criteria that are consistent with H&R applications. 2. LANL ALDESHQSS should eliminate "moderate" as a lift categorization for both lifting and material handling. 3. LANL ALDESHQSS should ensure that the use of non-routine material handling and/or lifting equipment results in a critical lift (or equivalent for material handling) categorization, thus driving specific considerations in the lift plan (or material move plan) development. 4. LANL ALDESHQSS should ensure that either P101-25 and/or

Cause	Discussion	Recommendation
	3. P101-25, *Cranes, Hoists, Lifting Devices, and Rigging Equipment,* as written, does not approach lift activities from a conservative position. Therefore, the controls associated with a critical lift were not applied to this evolution (such as consideration for a "dry run", verified removal of travel path obstructions, etc.).	a separate requirements document for jack and roll operations is set up in a conservative manner such that a critical lift (or move) is assumed until specific questions are answered that result in the activity moving from the critical lift categorization into ordinary lift, including the consideration of routine or non-routine lifting and moving equipment.
Root Cause 2	**Inadequate lift plan** **1.** The lift plan (not required for ordinary lifts) did not address key aspects of moving the load; e.g., transition points from elevated to zero energy, securing the load, cribbing, preventing hands from being under the load, or verifying a viable path of travel prior to moving the load. **2.** The lift plan was not executable as written. It did not consider that the toe jacks were positioned where the clamping frame needed to be positioned at the same time. It did not consider the irregular shape of the table and the resulting asymmetrical center of gravity associated with the load. Consequently, the load could not be affixed in a manner fully consistent with the manufacturer's instructions for the lifting device: the load was not affixed with the center of gravity at the	1. LANL should develop additional content criteria for inclusion in all lift plans, including ordinary lift plans; e.g., transition content, contingency plans, and means to support safe loading and movement. 2. Logistics leadership should develop criteria for when an ordinary lift requires a lift plan. The LOG-CS H&R department currently develops lift plans for all ordinary lifts. The investigation team concluded that this practice is diluting the rigor applied in lift plan development and therefore dilutes the value extracted from the lift plan.

Cause	Discussion	Recommendation
	position of the lifting device gimbal pins.	
Root Cause 3	**Inadequate work planning and work release led to a failure to invoke intended "hold points" during work execution.** 1. The IWD addressed the security door threshold removal and the security door alarm (in terms of re-activation, not specifically de-activation) but these were not communicated to the H&R supervisor and crew. 2. The IWD did not include a validation walk-through to ensure that the load and lifting device could freely travel through points of constraint along the path. 3. The H&R supervisor was not present at planned scoping walk-downs (in which controls for the work were suggested and/or intended to be refined in order to include them in the work package/IWD). 4. The PIC expected the crew to assemble the lifting device and load and then stop and await his return. He left the work area without communicating this expectation to the crew and his intended hold point was not included in the IWD.	LANL ALDESHQSS and Associate Laboratory Director for Capital Projects (ALDCP) should enhance H&R and material move work planning requirements as follows: 1. Ensure the planner and the H&R supervisor are present for the scoping walk-down along with the PIC, that they agree on any activity hold points, and that they jointly determine whether those hold points will be specified in the IWD or the lift plan (if an ordinary lift is being executed, the hold points should be in the IWD since a lift plan may not be required). 2. Work planning for such activities should include a hard requirement to validate the travel path, physical constraints along the path, and removal of obstructions prior to conducting a material move. 3. Line management should enforce effective pre-job briefs including the discussion and reinforcement of activity hold points. 4. ALDESHQSS should determine whether P300 provides for appropriate Subject Matter Expert (SME) review requirements for a lift plan that is part of a work package, but separate from the IWD.

Cause	Discussion	Recommendation
	5. The H&R supervisor initiated work without a pre-job brief of the IWD conducted by the PIC, as required by P300, so was not aware of the controls within the IWD relative to the security door alarm or threshold. Instead, the H&R supervisor reviewed only the lift plan with his rigging crew as well as the manufacturer's instructions for the lifting device. 6. The approval of the IWD on the day of the work contributed to an ineffective review of the IWD.	
Contributing Cause 1	**Inadequate oversight** The lack of a non-working supervisor or PIC and inadequate communication between the construction PIC and the Logistics H&R supervisor led to a failure to invoke certain controls listed in the IWD, to ensure a work environment that was less chaotic and distracting, and to appropriately pause the activity instead of modifying the lifting device while under load.	1. LANL ALDESHQSS should modify P300 as well as P101-25 to require the presence of a non-working PIC for H&R and material handling activities. 2. LANL ALDESHQSS should modify P300 to require a non-working supervisory role for all moderate and high hazard jobs.
Contributing Cause 2	**Lack of material moving equipment** The Logistics H&R crew was not experienced with the lifting device nor did their processes or procedures require more in-depth familiarization with new equipment prior to using it in a scheduled or actual work evolution. This resulted in the load not being properly affixed to the lifting device.	Logistics H&R should enhance work planning processes and procedures to ensure familiarity with material handling equipment prior to use by rigging crews.

Cause	Discussion	Recommendation
Contributing Cause 3	**Low perception of risk** The Logistics H&R crew and the CMRR PIC perceived the move task as low risk. This perception hindered everyone involved from exhibiting a questioning attitude and pausing work. This perception was demonstrated by a failure to conduct a pre-job brief, discussion of a non-viable travel path the morning of the move, and willingness to reconfigure the lifting device while under load.	Line management within Capital Projects and Logistics should reinforce the obligation to pause or stop work when conditions have changed or work cannot be performed as planned and documented in the IWD and/or lift plan/operational plan.

Additional recommendations from a review of similar events:

Issue	Discussion	Recommendation
Demonstrating value of safe performance of work as part of production and/or project work execution	In all work, personnel are continuously evaluating and determining when to emphasize efficiency and when to emphasize thoroughness. In project work, as with production work, milestones and work schedules are continuously emphasized. This creates an environment in which deliberate emphasis must be applied to ensure that work is executed in a safe manner.	1. Line management within Capital Projects and Logistics should develop expectations for field observations and coaching to reinforce expectations to perform effective pre-job briefs that include specified content to recognize the approved work bounding conditions and to pause when work cannot be performed within the planned boundaries. 2. Line management within Capital Projects and Logistics should ensure that the project schedule includes tasks to scope work and that resources including the planner, specified SMEs, and the PIC are required to be present for the scoping walk-down and to revise and refine the preliminary information that is supplied by the planner. This should be a hard requirement and subject to management observation and evaluation.

		3. Logistics and Capital Projects should ensure that work package review is conducted by SMEs in advance of the work execution in alignment with Conduct of Operations principles outlined in P315, Attachment 16, as well as P300 and PA-AP-01000 from TA-55.
Deliberate application of relevant Lessons Learned	The Joint Accident Investigation Team identified the fact that a subcontracting crew involved in the December event was not aware of previous event lessons learned involving the same subcontractor. Neither were Logistics H&R personnel familiar with the December subcontractor event or lessons learned (as discovered by this investigation team.) Failure to use such lessons to inform current work planning and work execution practices reflects a failure to emphasize organizational learning.	Logistics and Capital Projects should require that work planning and scoping include review of previous lessons learned and incorporation of the lessons learned into the current work plan, reference of the lessons learned, and review of the lessons learned during pre-job briefs.

5.0 HUMAN PERFORMANCE IMPROVEMENT ANALYSIS

5.1 Human Performance Evaluation

The human performance considerations of this accident investigation were undertaken per DOE Handbook 1028 2009, *Human Performance Improvement Handbook*, Volume 1, Section 1 14, "Anatomy of an Event". The investigating team determined that individual actions were taken in which personnel at several levels departed from expected behaviors and subsequently obtained unintended results, thus meeting the very definition of "human error." The crew failed at times to meet accepted standards of practice of which they were not aware due to deficiencies in management control processes and values.

Specific examination of human factors and their direct relationship to other project deviations and failed barriers are captured in Appendix B, *Barrier Analysis Worksheet*, and in Appendix C, *Events and Causal Factors Analysis*. Below only those factors that were deemed to have the most significant impact on the event are discussed.

5.2 Human Error Precursor, Flawed Defenses (Barriers), and Human Performance Tool Use Analysis

The investigation determined that the most prevalent error precursors and flawed defenses associated with organizational and programmatic (O&P) components were ineffective planning and scheduling and poor communication of plans. Examples include:

- The IWD included contingency tasks to facilitate removal of the security door threshold that presented a physical impediment to the move. The IWD further included additional information regarding deactivation of the security alarm. Though the crew signed the IWD, they did not review the IWD and were therefore unaware of this information.

- The PIC intended to communicate these factors verbally to the crew during a formal pre-job brief, but the brief did not occur.

- The lift plan was inappropriately classified as an "ordinary" lift. Had this work been classified as a "Critical Lift", it is highly likely that the hold points and contingencies documented in the IWD would have also been included in the lift plan and communicated to the crew in the pre-job brief.

The most significant human error precursors associated with worker-specific aspects of this event include the failure of the crew to adequately review work control documents (IWD), lack of familiarity with the equipment to be used, and willingness to reconfigure a lifting device while under load. Multiple error precursors were present but the crew did not recognize them as such and therefore did not pause and reevaluate. Examples of error precursors include:

- Logistics develops lift plans for all lifts regardless of classification, complexity, or location. Overreliance on these lift plans, which are typically written by the H&R supervisor, has conditioned the crew to rely upon them as their primary work instruction (i.e., administrative control/defense). Therefore, the H&R crew reviewed the lift plan but not the IWD.

- Some members of the crew had previously used lifting devices which were similar in appearance and function with some key differences to the Vere Optical Table Hoist. Logistics did not validate proficiency with the lifting device which negatively impacted the ability of the crew to operate the lifting device in accordance with manufacturer's instructions.

- The crew was not given a formal pre-job brief by the construction supervisor PIC before performing this work. Therefore work steps, hazards, and controls in the IWD were not communicated to the H&R crew.

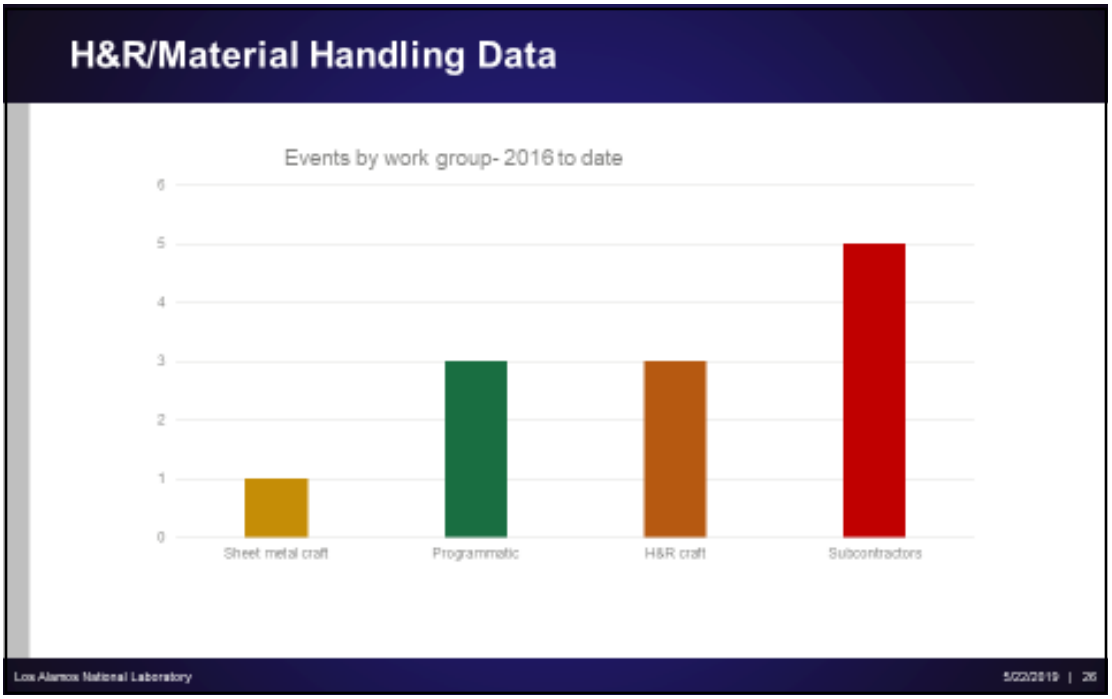
- The H&R supervisor was directly engaged in the task, preventing him from serving as independent oversight.

- Several impediments that prevented a successful move arose during the execution. The crew proceeded with troubleshooting and reconfiguring without pausing and re-assessing the situation. These impediments included:
  - The assembled load was too tall to fit through the doorway.
  - A threshold existed over which the load had to travel.
  - An imminent alarm created perceived time pressure.
  - The presence of multiple non-essential personnel created significant distractions

6.0 LESSONS LEARNED FROM SIMILAR INCIDENTS

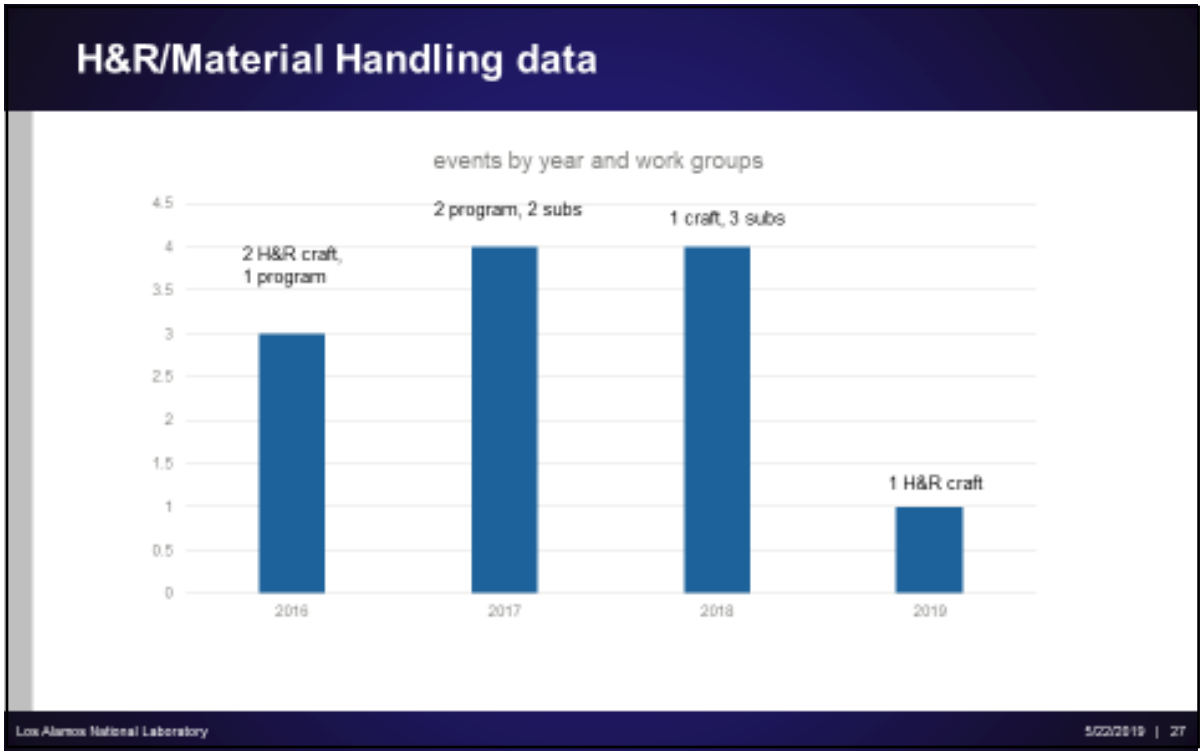
A review of eleven other ORPS and sub-ORPS events was performed by the investigation team. This review revealed several conditions associated with management systems and work execution that existed across the Laboratory, including programmatic work, Laboratory craft H&R and material move work, and subcontract H&R and material move work.
Of 12 events total (including the RLUOB toppled load) spanning from 2016, most reportable events involved subcontractors. Five of the 12 events involved subcontract work to include two events that occurred in close succession with the same subcontractor. Three events involved programmatic personnel and two involved the Logistics H&R craft. One other event involved sheet metal craft. See **Figure 1**.

Figure 1



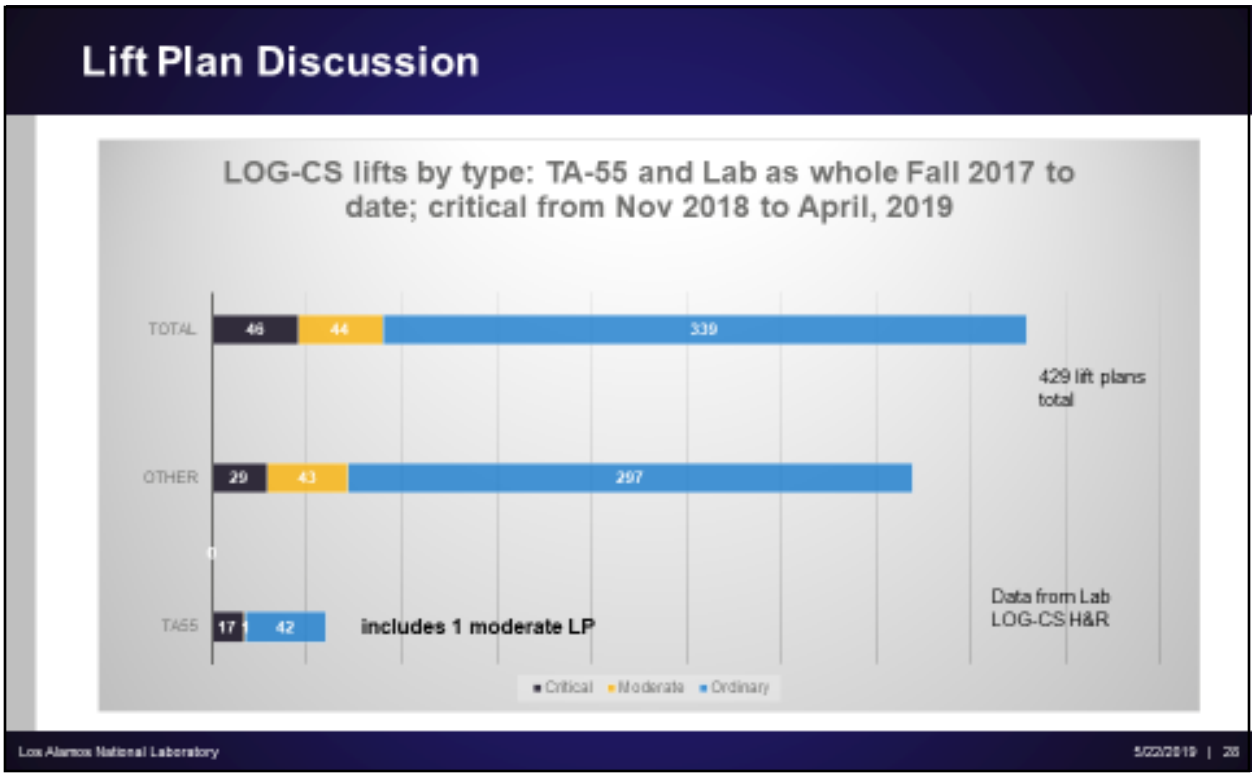
These events were distributed over time as follows: two events occurred in 2016, four in both 2017 and 2018, and one (to date) in 2019. The type of work that is executed by the LANL H&R crew was reviewed in order to understand (a) total H&R work activities in light of total reportable events, and (b) lift plan categorization trends. See **Figure 2**.

Figure 2



The Logistics H&R department provided 429 lift plans for review from across the Laboratory. These lift plans were for TA-55 and the Laboratory as a whole from the fall of 2017 to the information request date. The set of lift plans included critical lift plans from November of 2018 to the request date. Of all 429 lift plans, 60 were associated with TA-55. Of the 60, 42 lift plans or 70% of them were categorized as ordinary lifts. For the Laboratory as a whole, including TA-55, 339 of 429 lift plans or 79%, were categorized as ordinary. See **Figure 3.**

Figure 3



The data reflects an overwhelming use of the ordinary categorization, which, as discussed previously, involves less specific work planning requirements and plan content requirements that may adversely affect work execution if the lift is more complex. The data reviewed demonstrated two reportable events for 429 lift plans.

The investigation team identified four over-arching themes associated with causes of this and similar events:

1. Insufficient controls specified in work packages including IWDs and/or lift plans.

2. H&R requirements not supporting conservative decision-making with respect to lift categorization and therefore lift work planning.

3. Insufficient oversight of material lifting and moving operations.

4. On multiple occasions modifications were made to rigging or similar equipment while in the field, thereby deviating from an intended work plan based on a low perception of risk associated with this action.

Figure 4 illustrates the interrelationship of the primary common causes of material handling events.

The previously reported events included some events that contained no documented corrective actions. This is due to the fact that several events were categorized as low significance in the ORPS reporting criteria and therefore were subject to little or no analysis and lack of documentation requirements for corrective actions. In addition, at the conclusion of this accident investigation, the corrective action plan for the Joint Accident Investigation Report of the dropped lifting attachment *(Construction Lifting Accident at the Los Alamos National Laboratory Results in Serious Injuries to a Subcontract Employee on December 19, 2018*) was not yet approved and was therefore not reviewed by this team.

Nonetheless, several opportunities to prevent recurrence that could have been implemented were identified by this investigation team. In most events, the corrective actions were focused on addressing the immediate factors that contributed to the specific event and restarting the associated work.

For example, corrective actions associated with the dropped angle-iron focused on restart of the activity with added Subcontractor Technical Representative (STR) and ES&H oversight for the duration of the project. The corrective actions associated with the dropped spool pieces also targeted reinforcement of the cone of safety and provided for enhanced oversight during the

activity. Corrective actions associated with a dropped safe at TA-55 included a change to the lift plan categorization and re-work of the plan as well as a change to improved lifting and moving equipment and additional oversight for the task.

Overall, the implementation of corrective actions focused on the specific activity and were not applied systematically across the Laboratory to address what are actually cross-organizational and cross-functional issues. The investigation team recommends that the Laboratory place an emphasis on establishing and reinforcing a more conservative approach across projects, subcontracts, and craft with respect to the following:

1. **Enforce controls identified in lifting and material move plans**. Requirements need to drive more specific content and planning tasks for all lifts and material moves that *lie outside the realm of routinely used equipment*. This aspect of similar events was addressed in event specific recommendations.

2. **Properly categorize lifts to invoke additional rigor in planning and applied controls.** This will drive more specific, robust, and useful lift plans so that personnel can easily discern when they may not be able to perform the work as planned and are therefore more aware of when a pause of work is warranted. This aspect of similar events was addressed in event specific recommendations.

3. **Require PIC presence for all critical lift operations.** This PIC should be hands off. This perspective will allow greater involvement in managing the work environment to support successful and safe moves and will provide for more objective input regarding when work is deviating from the plan, requiring a work pause. This aspect of similar events was addressed in event specific recommendations.

4. **Value safe execution of work.** In all work, personnel continuously evaluate cost, schedule, and quality. Safety impacts to cost, schedule, and quality should be part of daily work planning and execution.

5. **Require incorporation of lessons learned into work authorizing documents.** Many of the incidents analyzed by the team were similar in nature across the Laboratory. Inclusion of lessons learned in work packages will help prevent recurrence.

   The Joint Accident Investigation Team identified that the subcontractor crew involved in the December Bobcat event was not aware of the same company's previous July angle iron event, both of which resulted in significant injuries. Furthermore, Laboratory Logistics H&R personnel were not familiar with these injury causing events or related lessons learned.

   Failure to use such lessons to inform current work planning and work execution practices reflects a failure to emphasize organizational learning. These should be applied to incorporate better controls into lift and move plans and to ensure that pre-job briefs are

conducted with an emphasis on the approved work activity as well as specification of hold points.

6. **The Laboratory should enhance training requirements for personnel involved in lifting and handling and material moves to recognize risks.** Because the involved craft or personnel conduct such tasks regularly, they are inclined to see the activity as standard or routine and focus on that rather than the life-threatening forces involved in these evolutions. This aspect of similar events was addressed in event specific recommendations.

APPENDICES

Appendix A: Memo, *Appointment of Accident Investigation Board*
Appendix B: Barrier Analysis
Appendix C: Events and Causal Factors Analysis
Appendix D: Acronyms

APPENDIX A: MEMO, *APPOINTMENT OF ACCIDENT INVESTIGATION TEAM*

Los Alamos NATIONAL LABORATORY EST. 1943

memorandum

Office of the Associate Laboratory Director
Weapons Production

To: Rubel Martinez, IQPA-PA, MS A147
Rita Henins, ORI-DO, MS E587
James Rammell, PIO-CM, MS P299
Brian McIlvaine, AMPP-DO, MS E500
Tony Shurter, LOG-SUP, MS P911
Denise McFather, AMPP-DO, MS E530
Delfido Anaya, LOG-CS, MS C919
Philbert Romero, OSH-ISH, MS P908
Thru: Robert C. Mason, TA55-DO, MS 583
From: David Eyler, ALDWP, MS E597
Phone: 505-667-5522
Symbol: ALDWP: 19-006
Date: March, 5, 2019

Subject: **Team Investigation: Near Miss to Personnel Injury while Moving Laser Equipment with Vere Optical Table Hoist**

On February 25, 2019, during movement of a specialty table weighing about 2,300 pounds, personnel modified an elliptical table hoist under load that resulted in the load and hoist falling over. Three persons were directly involved in moving the equipment. While it was mounted in the hoist frame. Although the personnel were not injured, there was a potential for injury since the three personnel were in close proximity to the load when it fell.

I am appointing a team to investigate this event. The following personnel are assigned to support the event investigation effort:

Rubel Martinez, IQPA-PA, MS A147 (Co-Team Leader)
Rita Henins, ORI-DO, MS E587 (Co-Team Leader)
James Rammell, PIO-CM, MS P299
Brian McIlvaine, AMPP-DO, MS E500
Tony Shurter, LOG-SUP, MS P911
Denise McFather, AMPP-DO, MS E530
Delfido Anaya, LOG-CS, MS C919
Philbert Romero, OSH-ISH, MS P908
Ronald Schroder, PIO-DO, J950

The scope of the investigation is to include, but not be limited to:

Identifying all relevant facts, and determining the direct, contributing and root causes of the event. This includes observation of the equipment and scene evidence, developing an understanding of the timeline of the event, interviewing the involved workers and work planners/preparers. The team will evaluate relevant management systems such as training and qualification, roles and responsibilities, the involved work control process, other related policies

and implementation of said policies and procedures, as well as relevant human performance issues.

The team will also review other events that have involved dropping loads at LANL within the past two years, to include:

- Dropped Spool Piece RLUOB Lab
  1110. September 2018
- Dropped UPS TA-55 Bldg 351
  March 2017
- Unrestrained lifting attachment resulting in injury at ECCCE Project
  December 2018

Per NA-LA direction, cost code XRSI 0000 0000 shall be used for this effort.

The investigation team will use analytical tools and techniques discussed in DOE Order 225.1B to include Events and Causal Factors and other tools/techniques identified as beneficial by the team. The outcome of the investigation will include the following:

- An articulation of the facts including the timeline, involved organizations, actions and outcomes;
- An assessment of the accident facts and circumstances
- A causal analysis and Human Performance Improvement analysis
- Direct, contributing and root causes of the event
- Common causes for multiple recurring events
- Organizational and management weakness that have led to failure to correct recurring issues

DEE:aar

Cc:

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APPENDIX B: BARRIER ANALYSIS

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
Scheduling of REI Project Activities	Ineffective	CMRR project did not enforce planning tasks that logically preceded the material move. Although the scoping walk-down identified the need to remove the scaffolding from the travel path for the load/install of the anti-vibration table and TEM/SEM, the REI project management did not protect that control. When the move/install task was accelerated by a week, the project did not confirm or enforce the predecessor tasks to ensure a safe travel path for the move, either through checklists, a hard hold point in the work package or the POD/POW readiness checks.	Scaffolding was supposed to be removed to allow for passage through to the destination lab. Scaffolding obstruction was not removed prior to day of lift, nor the day of the lift, nor during investigation team walk through	HPI Barriers: • Work Scheduling • Well communicated plans • Walk-downs HPI Precursors: • Imprecise communication habits • Unexpected equipment conditions HPI Tools: • Written communication
P300-Activity Work Planning IWD	Ineffective	1. A work package that included the scoping checklist, the IWD, and the lift plan was not provided to Hoisting and Rigging in advance of the work day. 2. The work package/IWD was not reviewed in terms of hazards,	a. (for #1 and #2 and #3): The Hoisting and Rigging Supervisor and crew had no knowledge of threshold removal possibility or the ability to deactivate the security door alarms	HPI Barriers: • Work planning • Well communicated plans • Planned contingencies • Procedure quality • Critical Steps

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
		controls, or hold points. The work did not require a lift plan, but referenced a lift plan. 3. The IWD did not define critical phases or hold points that PIC relied upon in his thought process (e.g., assemble the load and hoist, but stop there before transitioning to movement of the load) 4. Given all of the above, the IWD and corollary lift plan did not adequately specify the sequencing of tasks, corresponding controls, and hold points to ensure "what had to go right."	b. Although the PIC intended for the riggers to stop after assembly of the hoist to load, this was not communicated effectively to the Riggers so the Rigging Supervisor and the PIC had a divergent understanding of what tasks were to be completed that day. c. The PIC left the site at the time the riggers were preparing to assemble the hoist to the load. Verbal instruction was not given by the PIC to do nothing until the PIC could get out of his meeting. Nor was time taken out from his meeting to ensure a full pre-job was held although the assembly task work was imminent and that was part of the move/install work package.	• Field presence HPI Precursors: • Assumptions • Overconfidence • Lack of or unclear standards • Imprecise communication habits (PIC) HPI Tools: • Written communication • Verbal communication • Pre-Job Briefings
P101-25 Activity Work Planning Classification of Lift	Ineffective	Policy document is not set up to drive conservative decision-making. Instead, it discusses first an "ordinary lift" in 3.1.1 and describes it as not a critical or moderate lift. Then, instructs use of Form 1611 for ordinary lift. 1611 is used to classify the lift, but likely, the informal categorization has already been made	During initial scoping on 11/27/18, the lift is noted as an "ordinary lift." Because of the initial "categorization" requirements and because of an inaccurate risk perception, specific actions were not taken that would be required in a critical lift, such as	HPI Barriers: • Work planning • Risk Management HPI Precursors: • Inaccurate risk perception • Unclear Standards HPI Tools:

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
		when the form is selected. The user is to rely upon recall of definitions of critical lift rather than having the procedure decision gates serve a forcing function such that one has to demonstrate through a series of questions that they are NOT in a critical lift, then have requirements that drive gathering of information and developing knowledge that is translated into a lift plan regardless of categorization. Ordinary Lifts do not require a lift plan.	walking the path, doing a dry run, measuring or verifying all the constraints along the path of travel, etc. Several of these actions would have informed the rigging crew in advance of the move (alongside load/lifting device dimensions) that the load/lifting device was not going to get through the security door in a vertical position and would require manually managing the load at an angle and pushing/pulling to get over the threshold.	• Questioning Attitude • Self-Checking • Peer Checking • Job Site Review
P101-25 Activity Work Planning Lift Plan	Ineffective	1. The Lift plan, although reviewed and approved at the RLM level, did not contain information that would have prevented working under a suspended load (during assembly) 2. The lift plan included work steps that could not be executed in the field (e.g., the toe jacks were to be positioned at essentially the 4 "corners" of the anti-vibration table, but if placed there would	1. Personnel worked in a limited fashion underneath a suspended load when attaching all threads/clamps to the load. 2. Personnel did not have clearly identified "red flags" that would drive a work pause when they recognized the load and lifting device would have to be adjusted to	HPI Barriers: • Work Planning • Critical Steps • Procedure Quality HPI Precursors: • Unclear Standards • Inaccurate risk perception HPI Tools: • Procedure Use/Adherence

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
		interfere with the lifting device clamping assembly. 3. The lift plan did not incorporate hold points in the instance that the load could not traverse the intended path without modification to the load/hoist 4. The lift plan was reviewed but not used step by step, so was not followed. 5. The lift plan was reviewed by the H&R RLM, while the IWD was reviewed by other SMEs. The whole package was not reviewed by all SMEs.	get through the security door. 3. Personnel modified the lifting device while under load.	• Questioning Attitude (Stop when unsure)
P300 Activity Work authorization/ release Pre-Job Brief and/or communication between PIC and rigging crew	Ineffective	Although the Hoisting and Rigging Supervisor completed the worker signature portion of the pre-job brief, the pre-job, as described in P300, was not held by the PIC.	The PIC-identified stages in his mind in which he expected a hold point to be implemented, but these points were not communicated to the rigging crew.	HPI Barriers: • Clear performance standards • Well communicated plans • Clear, well communicated expectations HPI Precursors: • Change/Off normal • Inaccurate risk perception HPI Tools:

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
				• Verbal Communication • Written Communication • Pre-Job Briefings
Communication during work planning process	Ineffective	No one person served as an "integrator" in terms of capturing, consolidating, and communicating task hazards and controls, some of which were in the IWD and some of which were in the lift plan.	Planners had documented several controls that were intended to be implemented. Controls in the IWD were not integrated with the lift plan and vice versa. Therefore, all applicable controls were not adequately implemented for the work activity.	HPI Barriers: • Work planning • Planned contingencies • Critical Steps HPI Precursors: • Unclear goals, roles, responsibilities • Imprecise communication habits HPI Tools: • Written communication
Rigger training and knowledge	Ineffective	Although the Rigging Supervisor was knowledgeable about the importance of maintaining the center of gravity close to the axis of rotation, and was aware of the increase in load from the increase in length of the moment arm, this knowledge did not transfer to safe execution of the task. It did not drive the Rigging supervisor to ensure that the	The rigging crew focused on lowering and angling the load/lifting device to get it through the security door. In the process, they removed an all thread rod and the hitch pin that unified the whole lifting device while it was under load.	HPI Barriers: • Training • Clear, well communicated expectations HPI Precursors: • Inaccurate risk perception • Unsafe attitudes for critical tasks

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
		space between the hoist and the bearing remained between 1 and 4 inches as described in the manual, it did not trigger an awareness of the potential risk associated with the cant of the load and frame, and it did not serve to prevent modification of the hoist/frame while under load.		• Imprecise communication habits • New technique not used before HPI Tools: • Verbal Communication • Self-Checking • Questioning Attitude
R2A2	Ineffective	No one person was aware of the overall work situation and risks arising as work was performed. Therefore, no one had the overall perspective that risk was being incurred un-necessarily as the work progressed. No one was standing back to identify "red flags" and pause work.	The rigging crew was too close to the "problem" they were trying to solve regarding lowering and tilting the lift to successfully traverse the security door threshold.	HPI Barriers: • Roles and responsibilities • Promotes error reduction and risk management HPI Precursors: • Change/Off normal • Inaccurate risk perception • Indistinct problem solving skills • Stress/limited attention HPI Tools: • Stop when unsure • Self-Checking • Peer Checking

Barrier	How did the barrier perform	Why did the barrier fail?	How did the failure affect the event	Context ISM HPI
Cross-member hitch pin	Ineffective	Removed, along with all thread rod	Destabilized the load and allowed the load to drop and frame to topple.	HPI Barriers: • Machine Guards HPI Precursors: • Unfamiliar / first time • Unsafe attitudes for critical tasks • Inaccurate risk perception HPI Tools: • Questioning attitude • Procedure Use/Adherence • Self-Checking

APPENDIX C: EVENTS AND CAUSAL FACTORS

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
November 20, 2018	REI Work Package Manager emails peer planner that an IWD is needed to support vendor for "transportation, rigging/hoisting, security protocol steps, and anchoring."			
	Primary Planner requests supporting information from Work Package Manager			
	Work Package Manager sends "Scios Pre-Installation manual, Titan Themis 300 Low Base, SBT 436764-			

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	5009, -5015, 0435525-3003-02			
November 27, 2018	First Scoping walk-down for Work Order 628504-3 Task 03: RLUOB-SCIOS TEM/SEM MOVE/INSTALL LAB 1	*Purpose is to gather information that will be needed to develop an IWD for the TEM/SEM move into Lab 1109-1110*	Present: H/R LOG-RLM; primary and peer planner, PIC/Superintendent CMRR/REI, and Security.	1. Note the task title encompasses move and installation
		AP-WORK-002.1, Standard Activity and Scoping Checklist annotated	Scoping Checklist Notations: 1. Ordinary Lift 2. Table has to be configured to get into the Lab 3. Scaffolding will be out of path 4. With Scaffolding removed, tightest pinch point in through-way between gloveboxes is 50 inches 5. Rigging Group equipment to be used: "Gantry Crane" 6. Carpenters on standby to remove threshold at Security Door and to remove door at Lab 7. Soft start date set for 1/3 and vendor there 12/3	1. Basis for Ordinary lift categorization, Form 1611 from P101-25, is not yet filled out or signed by H&R. The planner entered this in the scoping checklist that he sent in advance of the 11/27 walk-down, as preliminary information to be discussed and revised as appropriate, by the SMEs in attendance during the walk-down. 2. No other path constraint measurements have been taken or documented. Planner indicates he expects PIC/H&R Supervisor to do that, but at the time of the first

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
				walk-down, the scaffolding was different than that observed after the incident or day of. Instead, it was of a type that only protruded a couple inches from the gloveboxes. (The configuration in the pass-through laboratory changed from the scoping timeframe) 3. Note that an Ordinary Lift does not require a lift plan and does not require a 'dry run' nor does a Moderate Lift. Neither require documenting a travel path or constraints 4. Note that P101-25 is not set up with forcing function such that user must start with critical lift categorization and demonstrate through answers to yes/no or quantifiable questions, that the lift is otherwise

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
				(moderate or ordinary) and neither require a lift plan, walk the path, get the constraints, etc. Only critical lift categorization requires these steps
12/12/18 Second Scoping Walk-down	For Work Order 628504-3 Task 03: RLUOB-SCIOS TEM/SEM MOVE/INSTALL LAB 1	Notes indicate that this walk-down involved review of a draft IWD for the task.	Attending: Primary planner and Security Rep	No Hoisting and rigging personnel present Question: How does construction project management oversee and prioritize the planning/work package development process? How do they drive the right participation/reviews to ensure correct step sequencing and hazard controls are identified and described in the work package?
		AP-WORK-002.1, Standard Activity and Scoping Checklist annotated	Notations: 1. Add escorts full time when security door breached	Because Security attends, most of the focus, based on notes, is on the security issues, not the rigging, the load, or the path.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
			2. Add verification point for security when security door closed 3. Add PIC to coordinate with Operations Center 4. Work Order cannot be published until lift plan supplied 5. TEM/SEM platform in crate available for H&R review	
December- Specific date is not confirmed	Work Order 628504-3 Task 03: RLUOB-SCIOS TEM/SEM MOVE/INSTALL LAB 1 Is moved out to March 4, 2019		PIC indicated in interview that the date was moved out to 3/4/19 because of delays in other tasks that precluded room availability, such as ventilation tie-in, etc.	Move dates fluctuates
December 12, 2018	Primary Planner provides updated scoping checklist and IWD Draft as well as open action items to H&R RLM and Rigging Supervisor, ESH,	Open Items include: 1. Rigging crew to review opened crate with platform 2. Lift plan to be published 3. Update target date for the move 4. Publish the Work Order		Per planner, this date reflected the project wanting to do the move on 1/3, just after Christmas break, which was discussed between planner and PIC and changed again.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	Construction Manager, others			
December-specific date is not confirmed	H&R communicates with Roads and Grounds and requests VERE Optical Table Hoist for the move	Vere was used at LANL once before moved to TA-55	H/R supervisor changed rigging equipment from originally identified gantry crane to VERE hoist	VERE table hoist never used by the 55 H&R Supervisor or riggers Vere may be considered unique H&R equipment Vere assembly may be straightforward, but load and assembly is not as straightforward-it is asymmetrical and the center of gravity is off-center of the pivot pins. P101-25 does not drive evaluation of unique H&R equipment as an input to determining process steps to verify load, equipment and path constraints.
December 19, 2018	H&R supervisor requests of primary planner that he be able to walk the job down that day	Work package partly hinges on development of lift Plan	H&R Supervisor responsible for development of lift Plan	1. Requirement for ordinary lift plan is not P101-25 driven, but H&R shop expectation driven. 2. Lift plan treated as corollary to IWD

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	H&R supervisor and PIC walk through the path this day	H&R supervisor stated conflicts prevented him from being on official walk-downs	H&R supervisor recalled that the primary path of travel as described in scoping checklists—the intended path of travel for the move—is the path discussed in the walk-down with the PIC and H&R supervisor.	Based on interview, the H&R supervisor recalled this occurred after official walk-down and before he developed lift plan.
December 21, 2018	PIC/Superintendent emails the H&R supervisor supporting docs.	Docs: "SBT-435525-3003-02-1, Pre-Installation-Titan Themis 300 Low Base"	Included anti-vibration table with dimensions, weights, center of gravity, etc.	
January 15, 2019	Primary Planner sends H&R supervisor and CMRR supervisor documents	Docs: "Appendix D-2 Scios Pre-Installation Manual.pdf; and Pre-Installation-Titan Themis 300 Low Base and SBT 43674-5009,-436764, -435525-3003-02-1"		
~January 15, 2019	H&R supervisor develops lift plan	Lift plan includes work steps (paraphrased): 1. Mobilize tools 2. Identifies other party to transport platform/table to loading dock 3. Placement of toe jacks on each end of the platform/table 4. Using the toe jacks to raise the table enough	1. H&R supervisor indicated he looked at the table/platform drawing and conferred with Vere to build the lift plan. 2. Plan appears to assume a horizontal position during travel, raise to straight vertical to get through standard door, and then back to horizontal, no angles between 90 or 180 during travel.	1. Plan cannot be executed as written. Jacks would interfere with hoist during assembly. Does not account for any other raised platform on which to set the optical table/platform such that table hoist could be attached. 2. No documentation indicating travel path constraints such as corners,

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		to be able to apply the table hoist 5. Connecting the table hoist to the table/platform 6. Verifying load stability 7. Travel to the lab 8. Before entry to the lab (apparently) raise to vertical and go through standard door 9. Rotate back to horizontal 10. Lower and use toe jacks to take weight of table/platform, 11. Remove the table hoist		intended path between gloveboxes, or doorways. 3. No documentation indicating dimensions of table plus VERE hoist. 4. Hoist with table would not fit through the security door in the vertical position and would not fit through the laboratory in the horizontal position. The IWD addressed neither of these constraints, nor does lift plan.
January 23, 2019	A second H&R supervisor sends email to REI Work Package Manager and Primary Planner with lift plan work steps attached	Email indicates to planner to ensure facility requirements complete and this work scheduled per "…your POD/POW requirements. When your work package is complete and at Ready please contact [H&R RLM] for RLM signature."	1. Email cc to H&R RLM and H&R supervisor 2. POD/POW for REI is on Thursday prior to upcoming week.	Work Order for this task can now publish PIC is not provided lift plan, but PIC does not have in depth knowledge of H&R. Indicates that and the fact that he relies on H&R supervisor for that knowledge and skill.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		Email contains attachments: Form 1611, signed Form 2215	1. Form 1611 categorizes the lift. Titled "Ordinary/Moderate Risk Lift Procedure." 2. Form 2215 is a non-mandatory aid from P101-25 that walks through pre-requisites so personnel can identify if they are applicable and if so, whether they have been completed.	Form 1611 does not include all questions from P101-25 additional forms that would drive consideration of lift being critical or warranting additional lift/load/material handling planning: (e.g. asymmetrical load, center of gravity of load, how to ensure safe distribution of load between 2 hoists around horizontal axis of rotation). Main body of P101-25 does not fully align with attached forms and form questions do not fully align with each other regarding how to determine a category of lift and what to do given that category.
	H&R RLM signs Form 1611	Ordinary Lift categorization	H&R RLM indicated in interview that Form 1611 is the basis for approving the lift as ordinary.	H/R RLM reviewed Form 1611 and the lift plan in absence of the IWD. There does not appear to be a driver to ensure controls from the IWD are flowed into a lift plan during planning or vice versa.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
January 28, 2019	Primary Planner forwards lift plan to PIC			
January 29, 2019	IWD for Work Order 628504-03, "RLUOB REI 2 LAB 1109-1110 SEM/TEM Equipment Move-In" signed by Primary Planner			
February 21, 2019	PIC and Primary Planner decide to move the lift up one week to 2/25/19	PIC indicated this was because the vendor could be there that day, the vendor had to be present to see their equipment was not damaged PIC indicated discussion had taken place to create a template of the table/platform to aid in evaluation of the optimal floor anchoring points. PIC also indicated, the best way to approach it was using the actual table/platform as the template so that actual dimensions represented for determining floor anchor		The decision is made with two working days between the decision and the work to be done.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		points that limited impingement of rebar.		
February 25, 2019	IWD for Work Order 628504-03, "RLUOB REI 2 LAB 1109-1110 SEM/TEM Equipment Move-In" is signed by: PIC, Field Engineer, Maintenance Coordinator, Construction Mgt., and ESH, as well as FOD	IWD: 1. Section 2- Precautions and Limitations 2.5 states "If steps cannot be completed as described, or if unforeseen situations occur, PAUSE WORK… " 2. Section 3, Pre-requisites/Initial Conditions under "Man-lift/Aerial lift" requires daily check/inspection of equipment before operation" 3. Same section 3 requires the lift to be operated ".. in accordance with the manufacturer's instructions" 4. Step 3.1: "Perform the Pre-Job brief; fill out the IWD Part 3. Provide daily pre-job		Neither the IWD nor the lift plan contain dimensions of the mounted load in the VERE nor dimensions of the load travel path constraints. Neither the IWD nor the lift plan contain hold points to ensure that once the load and hoist are assembled, the whole assembly can travel the whole path as intended. At this point, exact load path and viability of move sequence has not been verified and confirmed viable between H&R supervisor and PIC. Work package approval obtained same day as execution. At this point, the work activity is expected to be executed on this day.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		briefs before each scheduled activity." 5. Step 3.7: "PIC SHALL SEQUENCE move." 6. Section 5, Special Tools/Equipment requires the lift plan and carpenter tools 7. Section 7- Equipment Installation lab 8. Step 7.1: "PIC SHALL SEQUENCE INSTALLATION- Includes interaction with adjacent trades Contractors, Relevant Vendors … Coordinate communication for security door sensor removal with LIFT PLAN (2215/1611 and procedure [work steps] 9. 7.3- Verification Point- "VERIFY Hoisting and Rigging Operations Checklist Form 2215 is completed and filled		The PIC did not effectively communicate or direct the sequence of the move.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		out to PIC's satisfaction."		
February 25, 2019 ~ 0900	H&R general foreman is notified via telephone that the rigging crew was needed at RLUOB on this day.			
February 25, 2019 ~0930	Rigging crew arrive at the RLUOB work area and the rigging supervisor, PIC and riggers walk the path of travel for the load transport.	1. Riggers and PIC indicate that the original path and alternate path were both discussed that morning 2. H&R supervisor and riggers indicate that PIC verbalized the scaffolding in the laboratory (Rm. 1109) as part of original path would be out of their way before the move	Carpenters are needed to remove the scaffolding	Neither the IWD nor the lift plan contain dimensions of the mounted load in the VERE nor dimensions of the load travel path constraints. Dimensions and travel path constraints are not validated at this time.
		H&R supervisor and 2 other riggers have the following training and are current on that training: 1. Incidental Crane Operator	Jack and roll training is not inclusive of all lifting/material move devices. Riggers indicated they had experience with an older type of table "flipper" device, but not this rigid frame lifting device.	

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
		2. Qualified Crane Operator 3. Jack and Roll Training	Jack and roll training was indicated by riggers as being mostly math problems.	
	The PIC leaves to get the requisite signatures on the IWD that are outlined above.			
February 25, 2019	H&R supervisor and riggers go to see the crated table/platform			
	H&R supervisor provides riggers with VERE instruction manual and they review it.	The H&R supervisor has not used this piece of equipment before The riggers have not used this piece of equipment before	All of the riggers indicate they have used a less rigid, older model "flipper" before, just not this one. All of the rigging crew indicate the instructions look straightforward. No one has a sense that any added steps need to be taken to successfully load and transport.	Perception is this is low risk for Riggers.
	Riggers gather VERE in pieces for assembly and move via truck to RLUOB dock			

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	NPI-7 takes the crated table/platform from the warehouse to the staging area outside the RLUOB dock			
	Lunch break			
	PIC returns sometime in here.			
February 25, 2019 ~1300	Carpenters remove crate siding, exposing table/platform on pallet			
	PIC hands work package binder to H&R supervisor and leaves the area	PIC indicated he was to be present at a meeting upstairs RLUOB		At this point, based on collective interviews, the PIC is aware that riggers are about to assemble the load in the VERE. The PIC may not know that the lift plan work steps start with assembly, but the riggers are about to start conducting work activities.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
				At this time, the PIC does not identify the need to complete a full pre-job brief, but leaves the work package/binder with the H&R supervisor At this time, the PIC does not instruct the riggers to complete assembly only, then wait for him to do a full pre-job brief
	H&R Supervisor finds the Lift Plan and reviews with the Riggers	H&R supervisor indicates that he is the person responsible for the lift and he and PIC are confident in his ability to manage that portion of the work. They know what to do and they reviewed the detailed steps of the plan		At this time, the H&R supervisor does not pause work for a full pre-job brief by the PIC.
	Riggers sign Part 3 of the IWD.	Riggers indicate that they thought they would get a full pre-job brief, but then concluded this time they would not.	Riggers indicate that pre-job briefs vary depending on where the work is and who the PIC is.	At this time, the riggers did not perceive that the pre-job brief was an absolute pre-activity requirement, which would limit their asking for a pause.
	The riggers use toe jacks to lift the table/platform up off the pallet a few inches. Riggers			

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	place dunnage below the load.			
	NPI-7 places forklift tines below the table/platform and moves the table to the dock.	The table/platform load is not secured to the forklift.		HAZARD: The load could have also been dropped at this point in the work execution.
	NPI-7 maintains the table/platform at about waist high to facilitate the riggers applying the VERE lifting device to the load.	At this time, the load is not at zero potential energy. Cribbing is required to work on this load (per 101-25)		
	Rigging crew places the lifting device frames on each side of the table. The load and device are in horizontal position	Riggers use a wrench which must be located below the table to secure the all thread rods in place. During interview, riggers indicate that hands were at times beneath the load.		HAZARD: The load could have been dropped at this point in the work execution.
	Rigging crew places the VERE and load in a vertical position and uses hoists to raise/lower to			Note in Photo 1 that the load and frame are aligned vertically and the hoist is within the 1-4 inches away from clamping frame as required by the

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	verify stability of load.			manufacturer, but frame is already canted.
	H&R supervisor notes sufficient time to move the load to the destination lab.	Riggers indicated that the H&R supervisor had repeatedly informed them that they should not be rushed—that if there was time, they may move the load today, but if not, they could do it the next day.	Riggers also indicate (as well as H&R supervisor) that the VERE was committed for a different job the next day and that the H&R supervisor communicated this repeatedly to the PIC	
	Riggers start to move the load and pass through 3 high bay roll-up doors with ease.		H&R supervisor indicated he thought the load and frame were about 79 and ¾ inches in height from floor to top and all standard doors are about 80 inches.	At this time, the load path constraints not documented or verified as viable for travel by the PIC, the H&R supervisor, or the riggers.
	Rigging crew approaches within feet of the security door.			
	Rigging crew and H&R supervisor note the load/lifting device assembly will not pass through the	Riggers indicated that the frame needed to drop about 6 inches to get through the door.	Riggers also indicate that at this point they observe that the hoist frame on load short side is tilted towards the load and the frame on the high side is tilted away from the load.	Condition was missed as an opportunity to pause the work. Table winches were not operating in unison, thus causing some change in the load configuration.

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	door in an upright position.			
	Rigging crew tries to lower the load, but the clamp assembly contacts the cross member, limiting ability to lower further.	Riggers indicate that at this time, as they are preparing to get through the security door, they are surrounded by a crowd, some of whom are advising them, one touches the load, and the security POC is loudly and repeatedly informing them of the 90 second limit before the alarm goes off.		Neither the H&R supervisor nor the riggers know that the alarm could be de-activated because they were not present at the scoping, not informed by the PIC, and not reviewed in the IWD Rigging crew moves into "tunnel vision" and problem-solving mode at this point due to noise and distractions and the time constraints (related to the security door). Do not have recognition of the "bigger picture." Should have been an indication to pause.
	Rigging crew pulls the cross member pin that connects the two towers in order to lower the clamp assemblies further.	This action still would not allow the unit to clear the header on the security door.		Riggers pulled the pin under load. This is contrary to basic H&R applications. At this time, the person removing the pin is in problem-solving mode (get load low

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
				enough to get through the door) and is not recognizing the risk taken by modifying the load rigging while under load: The load is not secure; An individual could be beneath the load. All 4 rigging personnel agree to remove the pin.
	Rigging crew hoists load up so clamping frame clears cross member so that they can tilt the load. They do not reinstall the pin that had been pulled.	Riggers indicate the tilt was about 40 degrees from vertical.		Manufacturer does not intend for load to be maintained at an angle, thus no adjustment angle pins. Intended to be horizontal or vertical, with angle only pass-through on way to 90 or 180.
	Riggers attempt to rotate the load but one all thread interferes with the cross member beam.	1 of 4 all threads		

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	One all thread is removed under load.			Riggers pulled the all thread under load. This is contrary to basic H/R applications.
	Riggers then rotate the load in order to clear the header to travel through the double door.	Resulting in approx. 25% reduction in clamping force.		
	Rigging crew tries to push over threshold while maintaining the frame/load angle manually.	Insufficient momentum to get over the threshold.		
	Rigging crew backs up, forcefully pushes from farther back, one pulling the frame and two pushing the frame.			
	Rigging crew gets through the security doorway.			
	Rigging crew sees the original path is			

Date and Time	Event Sequence	Primary Condition	Condition related to Primary Condition or secondary condition	Notes
	still blocked by scaffolding.			
	H&R supervisor identifies alternate path and crew starts to move the load in that direction.			
	About 10 feet further down the path, the load drops and frame topples.			LOAD DROPS, HOIST FRAME TOPPLES. No injuries.

APPENDIX D: ACRONYMS

AC/MC	Analytical Chemistry and Materials Characterization
ALDESHQSS	Associate Laboratory Director for Environment, Safety, Health, Quality, and Safeguards & Security
ALD	Associate Laboratory Director
ALDWP	Associate Laboratory Director for Weapons Production
CMRR	Chemistry and Metallurgy Research Replacement
ES&H	Environment, Safety, and Health
FOD	Facility Operations Director
H&R	Hoisting and Rigging
HVAC	Heating, Ventilation, and Air Conditioning
IWD	Integrated Work Document
LANL	Los Alamos National Laboratory
LO/TO	Lock Out/Tag Out
LOG-CS	Logistics Central Shop
LOSA	Laboratory Operations Safety Academy
MOV	Management Observation and Verification
MSS	Maintenance and Site Services
MST	Materials Science and Technology
NPI	Nuclear Process and Infrastructure
ORPS	Occurrence Reporting and Processing System
PIC	Person in Charge
PPE	Personal Protective Equipment
REI	RLUOB Equipment Installation
RLM	Responsible Line Manager
RLUOB	Radiological Laboratory/Utilities/Office Building
SAFE	Safety Academy for Excellence
SME	Subject Matter Expert
STR	Subcontractor Technical Representative
WO	Work Order